Empowered by Innovation

# NEC

**8-bit All Flash**

# *78K0 Microcontrollers*
# *78K0S Microcontrollers*

ALL FLASH

Empower your creativity

**78K**

Embedded Controller

**Jul. 2008**

# Flash

## Shifting to "All Flash"

**All of our 8-bit general-purpose microcontrollers employ reliable flash memories.**
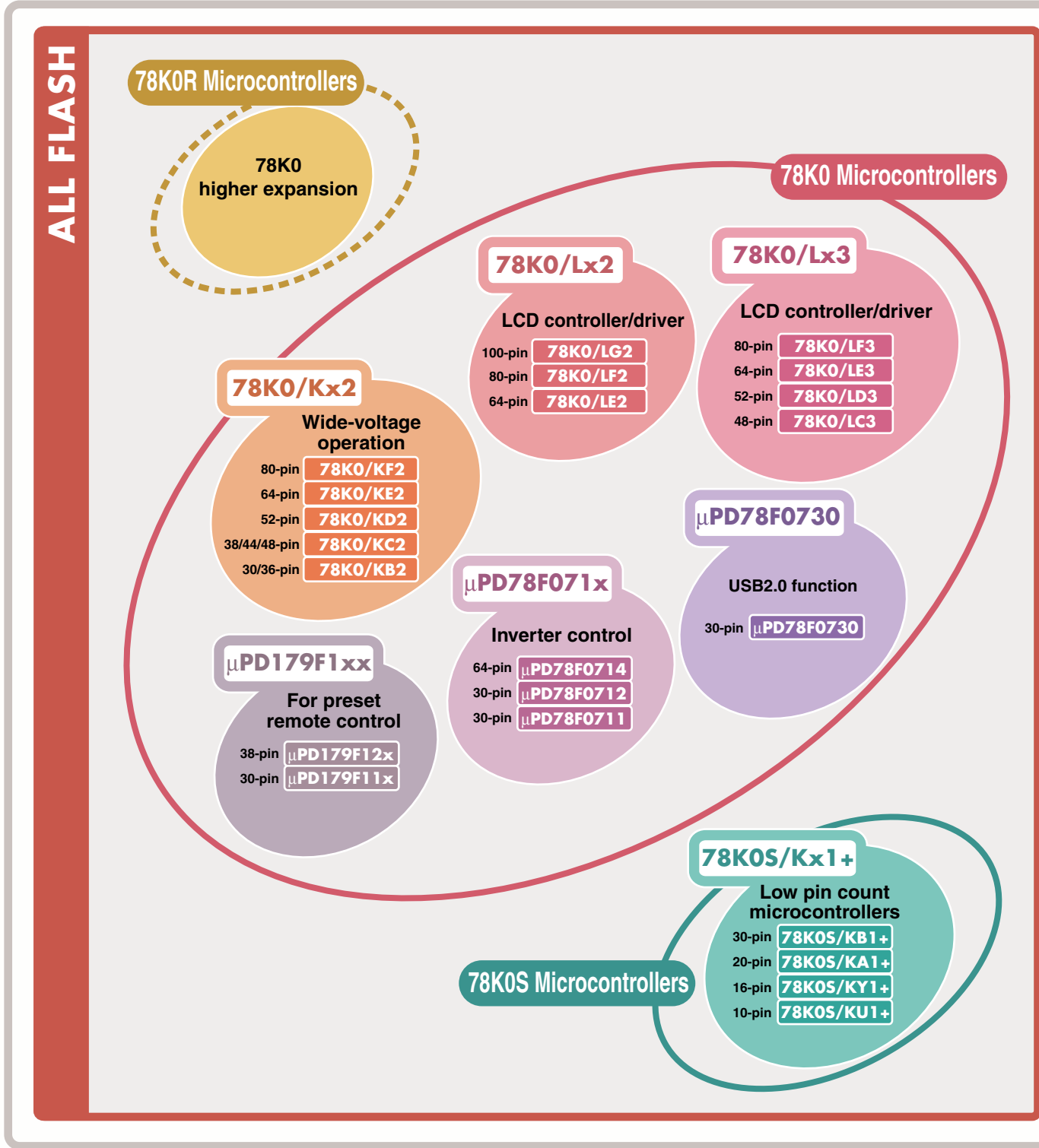
*A new evolution leading to system development success*

Answering ever more specific needs, contributing to cost cutting, delivering peace of mind that can be relied on.
To ensure that our diversified offering of 8-bit microcontrollers designed for many different applications truly empower our customers, which path should we aim for?
NEC Electronics, which has consistently been tracing the future course of microcontrollers, has come up with an answer, embodied by its shift to All Flash:
To offer a full lineup consisting entirely of flash memory products.
A truly diversified lineup that offers a full range of products, which are available with 10 to 100 pins and ROM capacity of 1 KB to 128 KB; cuts total cost by allowing program changes, the incorporation of peripheral functions, and lower power consumption; as well as providing a full range of development tools that dramatically enhance ease of use.
More than just providing its devices with sophisticated functions, NEC Electronics has also created an entire infrastructure that ranges from the development of flash microcontrollers to their delivery.

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## ALL FLASH

### 78K0R Microcontrollers
**78K0 higher expansion**

### 78K0 Microcontrollers

**78K0/Lx2**
LCD controller/driver
| | |
|---|---|
| 100-pin | 78K0/LG2 |
| 80-pin | 78K0/LF2 |
| 64-pin | 78K0/LE2 |

**78K0/Lx3**
LCD controller/driver
| | |
|---|---|
| 80-pin | 78K0/LF3 |
| 64-pin | 78K0/LE3 |
| 52-pin | 78K0/LD3 |
| 48-pin | 78K0/LC3 |

**78K0/Kx2**
Wide-voltage operation
| | |
|---|---|
| 80-pin | 78K0/KF2 |
| 64-pin | 78K0/KE2 |
| 52-pin | 78K0/KD2 |
| 38/44/48-pin | 78K0/KC2 |
| 30/36-pin | 78K0/KB2 |

**μPD78F071x**
Inverter control
| | |
|---|---|
| 64-pin | μPD78F0714 |
| 30-pin | μPD78F0712 |
| 30-pin | μPD78F0711 |

**μPD78F0730**
USB2.0 function
| | |
|---|---|
| 30-pin | μPD78F0730 |

**μPD179F1xx**
For preset remote control
| | |
|---|---|
| 38-pin | μPD179F12x |
| 30-pin | μPD179F11x |

**78K0S/Kx1+**
Low pin count microcontrollers
| | |
|---|---|
| 30-pin | 78K0S/KB1+ |
| 20-pin | 78K0S/KA1+ |
| 16-pin | 78K0S/KY1+ |
| 10-pin | 78K0S/KU1+ |

### 78K0S Microcontrollers

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## Application examples

All Flash microcontrollers are suitable for various application fields and raise the commercial value of customer systems.

**Cameras**
Digital still cameras, digital video cameras, SLR cameras

**Industrial equipment**
Industrial motors, control equipment, vending machines, power meters

**Audio**
Portable audio, component stereo systems

**Portable devices**
PDA, IC recorders

**Computer peripherals**
LBP, PPC, MFP, inkjet printers, scanners, fax machines

**Home appliances**
Air conditioners, refrigerators, washing machines, microwave ovens

**Video and recording equipment**
DVD players, DVD recorder, D-VHS, industrial cameras

**Remote control**
Preset remote control, etc.

**Other**
Electronic instruments, electric bidets, toys, etc.

# Flash microcontrollers can boost the competitiveness of your systems. Based on this concept, we are shifting to "All Flash".



## Flash microcontrollers offer overwhelming advantages.

Compared to mask ROM microcontrollers, flash microcontrollers definitely contribute to speeding up system development. Microcontrollers can be ordered before program completion, programs can be written even after the microcontroller has been mounted on the board, and thus microcontroller order placement and program development can be done concurrently, allowing TAT to be shortened as a result.

In addition, when flash microcontrollers are used for products with an ample lineup or that are localized for specific regions, ordering costs necessitated by mask ROM microcontrollers can be reduced and purchase and stock management costs can be slashed.

### ● For software designers

| Software development | Hardware development | Ordering | Production |

**Software can be changed just before mass production starts; development TAT can also be shortened.**
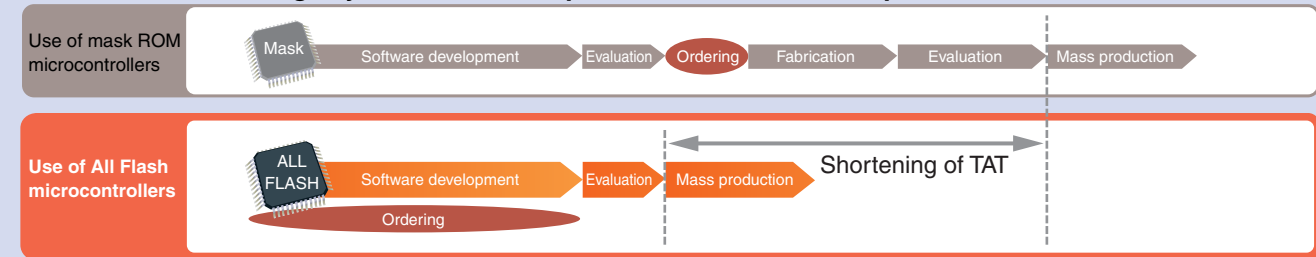


Since mask ROM microcontrollers cannot be ordered until their specifications are finalized, last-minute software changes can be problematic.
On the other hand, specifications for flash microcontrollers can be changed just prior to the start of mass production. Thus orders for flash microcontrollers can be placed while the software is still being developed, allowing the development TAT to be shortened.

### ● For hardware designers

| Software development | Hardware development | Ordering | Production |

**Mass-produced flash microcontrollers require evaluation only once, reducing development man-hours.**
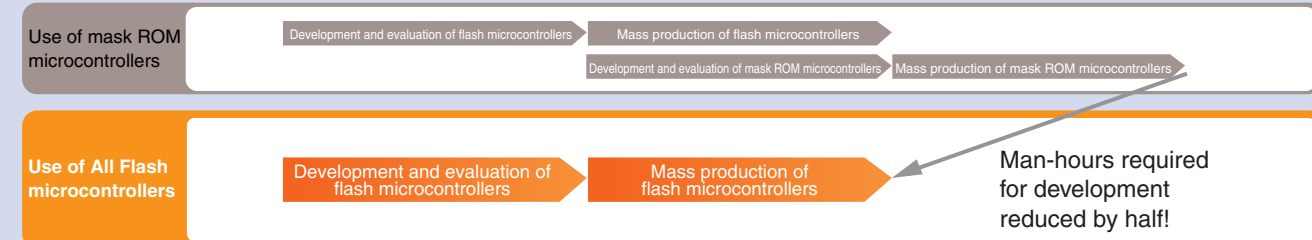


In the case of mass-produced mask ROM microcontrollers, evaluations of both flash microcontrollers and mask ROM microcontrollers are required.
Since evaluated flash microcontrollers can directly be mass-produced, the man-hours required for development are reduced by half, resulting in greatly shortened development TAT.

### ● For purchasing divisions

| Software development | Hardware development | Ordering | Production |

**Flash microcontrollers protect you from fluctuations in demand, can reduce dead stock.**
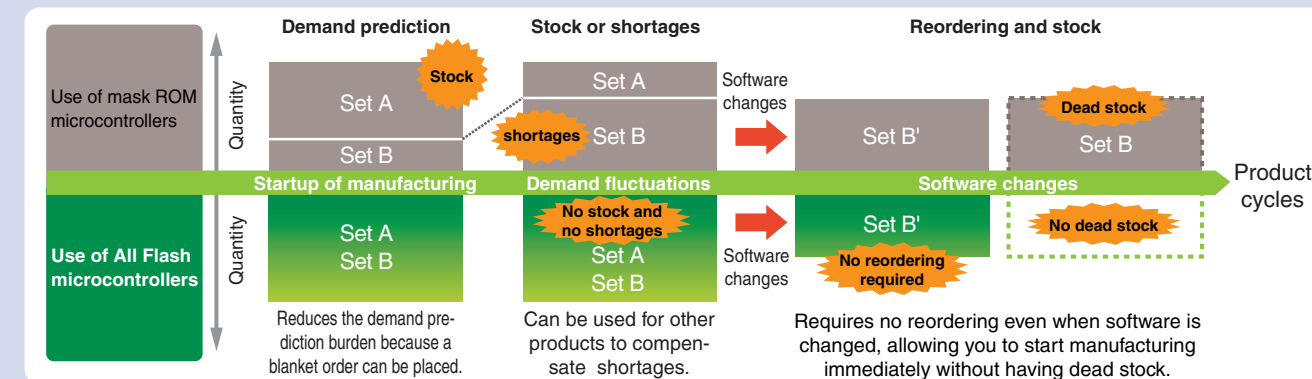


Mass-produced mask ROM microcontrollers may become dead stock as the result of changes in software or fluctuation in demand. On the other hand, flash microcontrollers can be mass-produced immediately after software changes and used for other products, resulting in fewer lost opportunities, less dead stock, and lower ordering cost.

### ● For manufacturing divisions

| Software development | Hardware development | Ordering | Production |

**Parts sharing makes production planning easier and boosts production efficiency.**
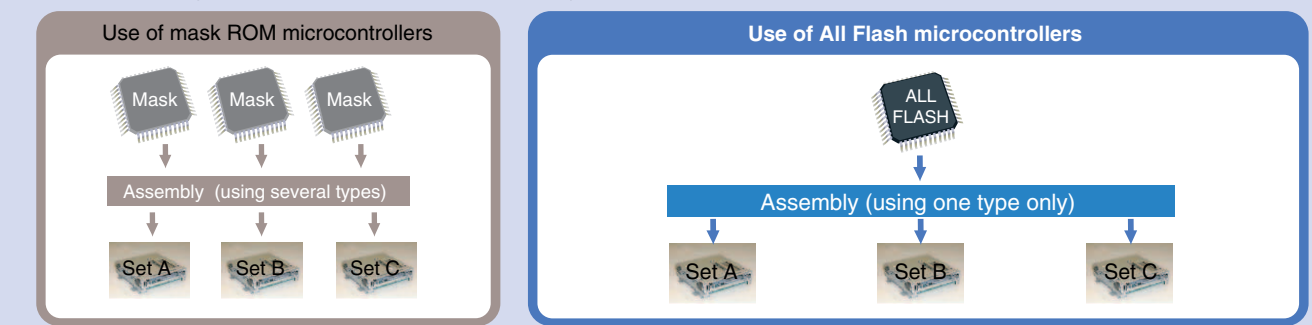


In the case of mass-produced mask ROM microcontrollers, the use of different software for different products necessitates the use of a different microcontroller for each type of product. In contrast, mass-produced flash microcontrollers facilitate the sharing of parts since they can be used for various products by simply rewriting the software.

# Unsure about flash microcontrollers? NEC Electronics can dispel your concerns in flash microcontrollers.

ALL **F**LASH

## "Reliability" is the concept.

Compared to mask ROM microcontrollers, flash microcontrollers definitely speed up system development. On the other hand, they are often considered as expensive and available in limited configurations. NEC Electronics has successfully cleared various hurdles by adapting development, production, sales, and distribution processes specifically for flash microcontrollers, to offer reliable microcontrollers that are attractive in all respects.

## Large selection

**Q**   Isn't the lineup limited?

**A**   We offer enhanced 216 products

To respond to demands for various types of microcontrollers, we offer a range of 216 All Flash 8-bit microcontrollers featuring various pin counts, ROM capacities, packages, etc. Among these, the 78K0/Kx2, 78K0/Lx2, and µPD78F071x feature an operation speed of 20 MHz, and the 78K0/Kx2, 78K0/Lx2, and 78K0/Lx3 feature a wide power supply range of 1.8 to 5.5 V. Our large selection allows you to select the best product to suit your needs.

■ Entire lineup consisting of flash memory products
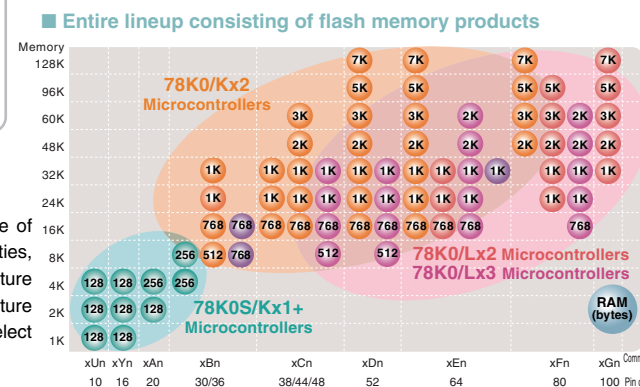


## Low cost

**Q**   Are these flash memory products expensive?

**A**   Our low prices overturn conventional notions.

We have drastically reduced costs through the application of new processes, etc., overturning the conventional notion that flash microcontrollers are expensive. Our microcontrollers use flash memory instead of EEPROM™, an internal oscillator, a voltage detection function (LVI), a reset function, and various other functions normally provided externally, which translates into considerably lower total system cost for you.

■ Total cost reduction through embedded peripheral IC functions

Flash memory
Reset function
Rice grain size despite rich content
Internal oscillator
64-pin chip size image
Voltage detection function (LVI, ADC)

The configuration on the right enables the operation thanks to the internal oscillator.
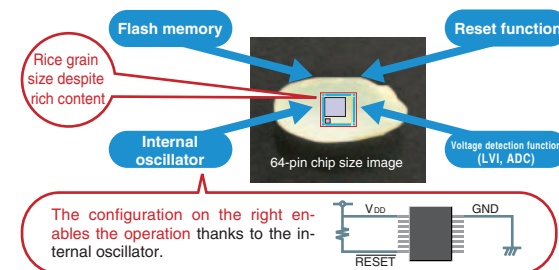
## Low power consumption

**Q**   Isn't the power consumption large?

**A**   About 1/3 that of mask ROM products.

Compared to the 7.6 mA operating current of conventional mask ROM products at 5 V/10 MHz operation (external ceramic resonator), the 78K0/Kx2, 78K0/Lx2, and 78K0/Lx3 products have a low operating current of 2.3 mA at 10 MHz operation (external ceramic resonator), and just 1.4 mA at 8 MHz operation (internal oscillator) under the same conditions. Thus lower power consumption than that of conventional mask ROM products can be achieved with our flash microcontrollers.

■ Realization of lower power consumption than mask ROM products

| Condition (5 V Power Supply Voltage) | | Operating current |
|---|---|---|
| Mask ROM products | External ceramic resonator 10 MHz | 7.6 mA |
| Flash memory (78K0/Kx2, 78K0/Lx2, 78K0/Lx3) | External ceramic resonator 10 MHz | 2.3 mA |
| | Internal oscillator 8 MHz | 1.4 mA |

Comparison with NEC Electronics products
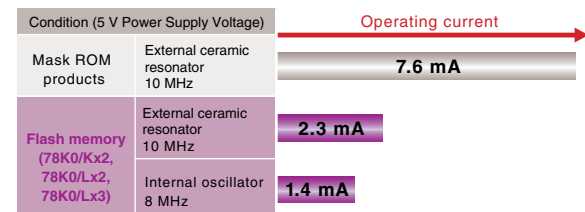
## High reliability

**Q**   Isn't the reliability low?

**A**   Our products incorporate our experience and technology in the automotive field as well as software protection functions.

All our products incorporate the experience we have gained in the process of supplying microcontrollers for over 1,000 types of applications and the technology we developed for flash microcontrollers for the automotive field. Our products also feature functions that disable reading and malicious software rewriting and erasing, thus offering maximum protection of your valuable software.

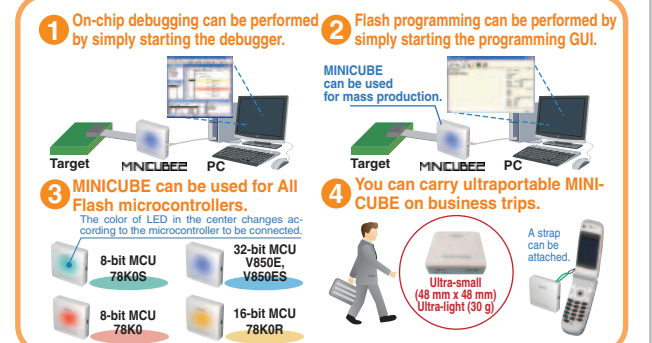■ Incorporated software protection functions

PG-FP5
Flash memory programmer

Writing → Writing   You can disable writing.
Erasing → Erasing   You can disable erasing.
Reading → Reading   No commands for reading are provided.
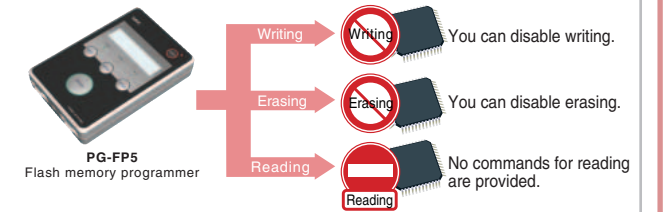
## Rich development environment

**Q**   No user-friendly development environment, right?

**A**   We offer inexpensive, easy-to-use, and convenient tools.

NEC Electronics provides inexpensive, easy-to-use, and convenient development environments. One example is MINICUBE2, an inexpensive on-chip debug emulator with flash programming function. Programming and on-chip debugging can be achieved for not only 78K0S/Kx1+ and 78K0/Kx2 and other 8-bit microcontrollers but also for 16- and 32-bit All Flash microcontrollers. Since the required cables come with MINICUBE and the software such as debuggers and programming GUIs can be downloaded from the website, you can use the debugger right away without having to purchase various accessories. Development environments for various applications are offered at low cost and a lineup of partner manufacturer tools is also available.

❶ On-chip debugging can be performed by simply starting the debugger.
Target   MINICUBE   PC

❷ Flash programming can be performed by simply starting the programming GUI.
MINICUBE can be used for mass production.
Target   MINICUBE   PC

❸ MINICUBE can be used for All Flash microcontrollers.
The color of LED in the center changes according to the microcontroller to be connected.
8-bit MCU 78K0S
8-bit MCU 78K0
32-bit MCU V850E, V850ES
16-bit MCU 78K0R

❹ You can carry ultraportable MINICUBE on business trips.
Ultra-small (48 mm x 48 mm) Ultra-light (30 g)
A strap can be attached.

## Support for mass production

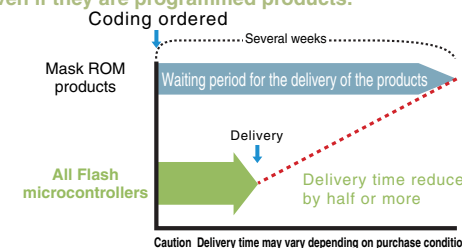**Q**   Isn't programming cumbersome during mass production?

**A1**   In addition to a large lineup of programming tools, we also offer programming services.

NEC Electronics and partner manufacturers offer a large number of programming tools, making programming possible in many different settings such as development environments and production lines. Moreover, programming services are also available from partner manufacturers both in Japan and overseas, serving a broad range of needs such as large-volume programming after shipping.

**A2**   We offer programmed products.

The programmed products are shipped similarly to mask ROM products.

■ Shorter delivery time than that of mask ROM products, even if they are programmed products.

Coding ordered
Mask ROM products
Waiting period for the delivery of the products
Several weeks
Delivery
All Flash microcontrollers
Delivery time reduced by half or more

Caution: Delivery time may vary depending on purchase conditions such as order quantity.

■ Programming environment supporting All Flash products

Flash memory programmers made by NEC Electronics
PG-FP5   MINICUBE2

Flash memory programmers made by partner manufacturers
Naito Densei Machida Mfg. Co., Ltd.
Yokogawa Digital Computer Corporation
Wave Technology Co., Ltd.
FL-PR5   NET IMPRESS Series   Y3000-8
Application Corporation   Interface Co., Ltd.
Stick GANG Writer   StickWriter   ITF2000

Flash microcontroller

Programming houses
Matsubara.KK   ROMTEC   Beichmann   4 SOURCE
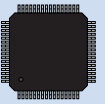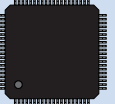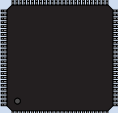LIBERTY   ertec   TELFORD   TAKUMI SHOJI CO.,LTD
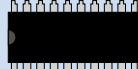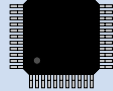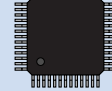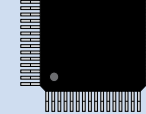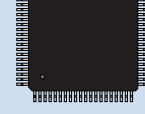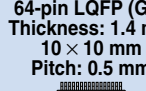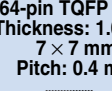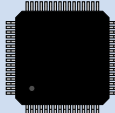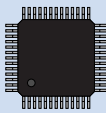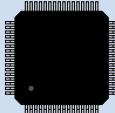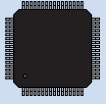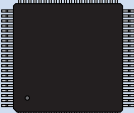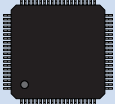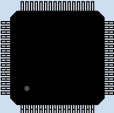
78K0S/Kx1+
78K0/Kx2

**We offer flash microcontrollers in various packages and ROM or RAM sizes, allowing you to select the best flash microcontroller for your product or application.**

| Commercial Name | 78K0S/KU1+ | 78K0S/KY1+ | 78K0S/KA1+ | 78K0S/KB1+ | 78K0/KB2 | 78K0/KC2 | | | 78K0/KD2 | 78K0/KE2 | 78K0/KF2 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Pin Count** / ROM (bytes) | 10-pin | 16-pin | 20-pin | 30/32-pin | 30/36-pin | 38-pin | 44-pin | 48-pin | 52-pin | 64-pin | 80-pin |
| 128 K | Product name (RAM (bytes)) | | | | | | | | µPD78F0527A, µPD78F0527DA*2 (7 K) | µPD78F0537A, µPD78F0537DA*2 (7 K) | µPD78F0547A, µPD78F0547DA*2 (7 K) |
| 96 K | | | | | | | | | µPD78F0526A (5 K) | µPD78F0536A (5 K) | µPD78F0546A (5 K) |
| 60 K | | | | | | | | µPD78F0515A, µPD78F0515DA*2 (3 K) | µPD78F0525A (3 K) | µPD78F0535A (3 K) | µPD78F0545A (3 K) |
| 48 K | | | | | | | | µPD78F0514A (2 K) | µPD78F0524A (2 K) | µPD78F0534A (2 K) | µPD78F0544A (2 K) |
| 32 K | | | | | µPD78F0503A, µPD78F0503DA*2 (1 K) | µPD78F0513A, µPD78F0513DA*2 (1 K) | µPD78F0513A, µPD78F0513DA*2 (1 K) | µPD78F0513A (1 K) | µPD78F0523A (1 K) | µPD78F0533A (1 K) | |
| 24 K | | | | | µPD78F0502A (1 K) | µPD78F0512A (1 K) | µPD78F0512A (1 K) | µPD78F0512A (1 K) | µPD78F0522A (1 K) | µPD78F0532A (1 K) | |
| 16 K | | | | | µPD78F0501A (768) | µPD78F0511A (768) | µPD78F0511A (768) | µPD78F0511A (768) | µPD78F0521A (768) | µPD78F0531A (768) | |
| 8 K | | | | µPD78F9234 (256) | µPD78F0500A (512) | | | | | | |
| 4 K | µPD78F9202, µPD78F9502 (128) | µPD78F9212, µPD78F9512 (128) | µPD78F9222 (256) | µPD78F9232 (256) | | | | | | | |
| 2 K | µPD78F9201, µPD78F9501 (128) | µPD78F9211, µPD78F9511 (128) | µPD78F9221 (128) | | | | | | | | |
| 1 K | µPD78F9200, µPD78F9500 (128) | µPD78F9210, µPD78F9510 (128) | | | | | | | | | |

**78K0S/Kx1+ Microcontrollers (Low Pin Count Microcontrollers)**

**78K0/Kx2 Microcontrollers**

**Package**

| 10-pin SSOP (MA) Thickness: 1.2 mm 5.72 mm (225) Pitch: 0.65 mm | 16-pin SDIP*1 (CS) Thickness: 2.8 mm 7.62 mm (300) Pitch: 1.778 mm | 20-pin SDIP (CS) Thickness: 2.8 mm 7.62 mm (300) Pitch: 1.778 mm | 32-pin SDIP (CS) Thickness: 2.8 mm 7.62 mm (300) Pitch: 1.778 mm | 30-pin SSOP (MC) Thickness: 1.2 mm 7.62 mm (300) Pitch: 0.65 mm | 38-pin SSOP (MC) Thickness: 1.7 mm 7.62 mm (300) Pitch: 0.65 mm | 44-pin LQFP (GB) Thickness: 1.4 mm 10 × 10 mm Pitch: 0.8 mm | 48-pin LQFP (GA) Thickness: 1.4 mm 7 × 7 mm Pitch: 0.5 mm | 52-pin LQFP (GB) Thickness: 1.4 mm 10 × 10 mm Pitch: 0.65 mm | 64-pin LQFP (GC) Thickness: 1.4 mm 14 × 14 mm Pitch: 0.8 mm / 64-pin LQFP (GK) Thickness: 1.4 mm 12 × 12 mm Pitch: 0.65 mm | 80-pin LQFP (GC) Thickness: 1.4 mm 14 × 14 mm Pitch: 0.65 mm |

16-pin SSOP (GR) Thickness: 1.44 mm 5.72 mm (225) Pitch: 0.65 mm

20-pin SSOP (MC) Thickness: 1.2 mm 7.62 mm (300) Pitch: 0.65 mm

30-pin SSOP (MC) Thickness: 1.2 mm 7.62 mm (300) Pitch: 0.65 mm

36-pin FLGA (FC) Thickness: 0.91 mm 4 × 4 mm Pitch: 0.5 mm

64-pin LQFP (GB) Thickness: 1.4 mm 10 × 10 mm Pitch: 0.5 mm / 64-pin TQFP (GA) Thickness: 1.0 mm 7 × 7 mm Pitch: 0.4 mm

80-pin LQFP (GK) Thickness: 1.4 mm 12 × 12 mm Pitch: 0.5 mm

16-pin WLBGA*1 (FH) Thickness: 0.4 mm 2 × 2.3 mm Pitch: 0.5 mm

20-pin WLBGA*3 (FH) Thickness: 0.4 mm 2.1 × 2.6 mm Pitch: 0.5 mm

64-pin FLGA (FC) Thickness: 0.91 mm 5 × 5 mm Pitch: 0.5 mm / 64-pin FPBGA*3 (F1) Thickness: 0.69 mm 4 × 4 mm Pitch: 0.4 mm

*1 µPD78F9210, 78F9211, and 78F9212 only  *2 Supports on-chip debugging of 78K0/Kx2  *3 Under development
**Remark** The packages are shown in their actual size.

Side tabs: 78K0/Lx2 · 78K0/Lx3 · μPD78F071x · μPD78F0730 · μPD179F1xx

**We offer flash microcontrollers in various packages and ROM or RAM sizes, allowing you to select the best flash microcontroller for your product or application.**

| ROM (bytes) | μPD179F1xx 30-pin | μPD179F1xx 38-pin | μPD78F0730 30-pin | μPD78F071x 30-pin | μPD78F071x 64-pin | 78K0/LC3 48-pin | 78K0/LD3 52-pin | 78K0/LE3 64-pin | 78K0/LF3 80-pin | 78K0/LE2 64-pin | 78K0/LF2 80-pin | 78K0/LG2 100-pin |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 128 K | Product name (RAM (bytes)) | | | | | | | | | | | μPD78F0397, μPD78F0397D*2 (7 K) |
| 96 K | | | | | | | | | | | μPD78F0376, μPD78F0386, μPD78F0376D*2, μPD78F0386D*2 (5 K) | μPD78F0396 (5 K) |
| 60 K | | | | | | | | μPD78F0445, μPD78F0455, μPD78F0465*1 (2 K) | μPD78F0485, μPD78F0495*1, μPD78F0475 (2 K) | | μPD78F0375, μPD78F0385 (3 K) | μPD78F0395 (3 K) |
| 48 K | | | | | | | | μPD78F0444, μPD78F0454, μPD78F0464*1 (2 K) | μPD78F0484, μPD78F0494*1, μPD78F0474 (2 K) | | μPD78F0374, μPD78F0384 (2 K) | μPD78F0394 (2 K) |
| 32 K | μPD179F114 (1 K) | μPD179F124 (1 K) | | | μPD78F0714 (1 K) | μPD78F0403, μPD78F0413 (1 K) | μPD78F0423, μPD78F0433 (1 K) | μPD78F0443, μPD78F0453, μPD78F0463*1 (1 K) | μPD78F0483, μPD78F0493*1, μPD78F0473 (1 K) | μPD78F0363, μPD78F0363D*2 (1 K) | μPD78F0373, μPD78F0383 (1 K) | μPD78F0393 (1 K) |
| 24 K | μPD179F113 (1 K) | μPD179F123 (1 K) | | | | μPD78F0402, μPD78F0412 (1 K) | μPD78F0422, μPD78F0432 (1 K) | μPD78F0442, μPD78F0452, μPD78F0462*1 (1 K) | μPD78F0482, μPD78F0492*1, μPD78F0472 (1 K) | μPD78F0362 (1 K) | μPD78F0372, μPD78F0382 (1 K) | |
| 16 K | μPD179F112 (768) | μPD179F122 (768) | μPD78F0730 (3 K) | μPD78F0712 (768) | | μPD78F0401, μPD78F0411 (768) | μPD78F0421, μPD78F0431 (768) | μPD78F0441, μPD78F0451, μPD78F0461*1 (768) | μPD78F0481, μPD78F0491*1, μPD78F0471 (768) | μPD78F0361 (768) | | |
| 8 K | μPD179F111 (512) | | | μPD78F0711 (768) | | μPD78F0400, μPD78F0410 (512) | μPD78F0420, μPD78F0430 (512) | | | | | |
| 4 K | μPD179F110 (512) | | | | | | | | | | | |
| 2 K | | | | | | | | | | | | |
| 1 K | | | | | | | | | | | | |

**Microcontrollers for Preset Remote Control**

**USB Micro-controllers**

**Microcontrollers for Inverter Control**

**78K0/ Lx3 Microcontrollers**

**78K0/Lx2 Microcontrollers**

**Package**

- 30-pin SSOP (MC) Thickness: 1.2 mm 7.62 mm (300) Pitch: 0.65 mm
- 38-pin SSOP (MC) Thickness: 1.7 mm 7.62 mm (300) Pitch: 0.65 mm
- 30-pin SSOP (MC) Thickness: 1.2 mm 7.62 mm (300) Pitch: 0.65 mm
- 30-pin SSOP (MC) Thickness: 1.2 mm 7.62 mm (300) Pitch: 0.65 mm
- 64-pin TQFP (GK) Thickness: 1.0 mm 12 × 12 mm Pitch: 0.65 mm
- 48-pin LQFP (GA) Thickness: 1.4 mm 7 × 7 mm Pitch: 0.5 mm
- 52-pin LQFP (GB) Thickness: 1.4 mm 10 × 10 mm Pitch: 0.65 mm
- 64-pin LQFP (GK) Thickness: 1.4 mm 12 × 12 mm Pitch: 0.65 mm / 64-pin LQFP (GB) Thickness: 1.4 mm 10 × 10 mm Pitch: 0.5 mm
- 80-pin LQFP (GC) Thickness: 1.4 mm 14 × 14 mm Pitch: 0.65 mm / 80-pin LQFP (GK) Thickness: 1.4 mm 12 × 12 mm Pitch: 0.5 mm
- 64-pin LQFP (GK) Thickness: 1.4 mm 12 × 12 mm Pitch: 0.65 mm / 64-pin LQFP (GB) Thickness: 1.4 mm 10 × 10 mm Pitch: 0.5 mm
- 80-pin LQFP (GC) Thickness: 1.4 mm 14 × 14 mm Pitch: 0.65 mm / 80-pin LQFP (GK) Thickness: 1.4 mm 12 × 12 mm Pitch: 0.5 mm
- 100-pin LQFP (GC) Thickness: 1.4 mm 14 × 14 mm Pitch: 0.5 mm

*1 Under development
*2 Supports on-chip debugging of the 78K0/Lx2 microcontroller
**Remark** The packages are shown in their actual size.

# Low cost

**All the required peripheral functions are provided on chip, saving you money and space.**

## Total cost reduction achieved through the following on-chip peripheral functions



EEPROM  Resonator  Reset & WDT IC

Conventional mask ROM microcontrollers → Board downsizing (78K0/Kx2, 78K0/Lx3) → Package downsizing (78K0S/Kx1+)

### ■ Internal oscillator

Various oscillators are embedded. The flash microcontroller can operate with just an internal oscillator.

External clock  or  External resonator

Low-speed internal oscillator → Watchdog timer *1
X1 clock → CPU
Sub-clocks *2
High-speed internal oscillator → Peripheral functions *3

The external resonator pin can be used as an I/O if no external resonator is needed.

**The configuration below enables the operation.**
VDD  GND  RESET

*1  78K0S/Kx1+ and μPD78F071x only
*2  Sub-clocks are not provided for the 78K0/KB2, 78K0S/Kx1+, μPD78F0730, and μPD179F1xx.
*3  Use an external resonator or an external input clock when using the USB function incorporated in the μPD78F0730.

### ■ EEPROM emulation function *4

Any block can be used as nonvolatile memory for storing data with the self-programming function of the flash memory.

Minimum erasure units
78K0/Kx2:    1 KB
78K0/Lx3:    1 KB
78K0S/Kx1+: 256 bytes

Writing of next data item (Data 2)

Data 1  →  Data 2 / Data 1

Maximum number of data items stored in one block (Outline)

$$\frac{\text{Minimum erasure unit}}{\text{Data length (number of bytes)}} \times \text{Number of erasures in one block}^{*5}$$

*4  Except μPD78F071x, μPD78F0730, and μPD179F1xx
*5  78K0S/Kx1+: 1,000 times, 78K0/Kx2: 10,000 times (4 KB), 78K0/Lx3: 10,000 times (4 KB)
Remark  See the user's manual (EEPROM emulation library) for details.

### ■ Reset function

Highly accurate and user-friendly voltage detection and reset functions are incorporated.

**Power-on clear function**

**Reduces external resets and voltage detection ICs.**

Release of reset  Power supply voltage (VDD)  Occurrence of reset
Voltage detected

1.59 V ±0.15 V (fixed)  78K0/Kx2  78K0/Lx2  78K0/Lx3  μPD78F0730
1.80 V ±0.1 V (fixed)  μPD179F1xx
2.1 V ±0.1 V (fixed)  78K0S/Kx1+
3.5 V ±0.2 V (fixed)  μPD78F071x

**Voltage detection function**

**Interrupt or reset can be selected by software.**

Interrupt or reset  Power supply voltage (VDD)  Interrupt or reset
Voltage detected
Selectable with software

**Accuracy of ±0.1 V***

*  78K0/Kx2, 78K0/Lx3, 78K0/Lx2, μPD78F0730, μPD179F1xx: When any voltage is set
78K0S/Kx1+: When a voltage of 2.6 V or less is set
μPD78F071x: Accuracy of ±0.2 V

12 V  Regulator IC  5 V  VDD pin
1.3 V  78K0/Kx2, 78K0/Lx3, 78K0/Lx2
EXLVI pin (alternately used as a port)

**The 78K0/Kx2, 78K0/Lx3, and 78K0/Lx2 also have the functions on the right.**

Includes a pin (EXLVI) for inputting a reference voltage, allowing the detection of power supply voltages including power supply voltage for the microcontroller (VDD).

### ■ Highly reliable watchdog timer

Refer to the watchdog timer description on page 15.

---

# Low power consumption

**The low power consumption is comparable to that of conventional mask ROM products, allowing you to build more eco-friendly systems.**

## Low power consumption comparable to that of mask ROM products

### ■ Power supply voltage: 5 V

**Operating current**

| | | | | |
|---|---|---|---|---|
| Conventional mask ROM microcontrollers | Operation mode | Resonator 10 MHz | 7.6 mA | |
| 78K0/Kx2, 78K0/Lx3, 78K0/Lx2 | | Resonator 10 MHz | 2.3 mA | 70% reduced |
| | | Internal oscillator 8 MHz | 1.4 mA | 82% reduced |

### ■ Power supply voltage: 3 V

**Standby current**

| | | | | |
|---|---|---|---|---|
| Conventional mask ROM microcontrollers | HALT mode | Resonator 32.768 kHz | 6 μA | |
| 78K0/Kx2, 78K0/Lx2 | | Resonator 32.768 kHz | 3.5 μA | 42% reduced |
| 78K0/Lx3 | | Resonator 32.768 kHz | 2.4 μA | 60% reduced |
| 78K0/Kx2, 78K0/Lx3, 78K0/Lx2 μPD179F1xx | STOP mode | All clocks stop. | 1 μA | |

**Remark**  The current values are typical values.

**The internal oscillator allows fast startup, eliminating the need for oscillation wait time and reducing average power consumption.**

## Power-consumption reduction achieved by fast startup

**Microcontrollers without internal oscillator**

Wait time + oscillation stabilization time: Several ms to several dozen ms

Microcontroller operation starts with clock from external resonator.

**Wait time for oscillation stabilization is required** at the beginning of the oscillation.

At power on
**78K0, 78K0S All Flash**
Wait  70.83 μs (TYP.)*1  Microcontroller operation starts with internal oscillation clock.

When standby is released
**78K0, 78K0S All Flash**
STOP mode  Wait  2.4 μs (TYP.)*2,3  Microcontroller operation starts with internal oscillation clock.

Internal oscillators require almost no wait time for oscillation stabilization.
The non-productive time intervals indicated by the arrows above are eliminated, which reduces the average power consumption.

*1  In the case of the μPD78F071x. 78K0S/Kx1+: 544 μs (TYP.)
*2  In the case of the 78K0/Kx2, 78K0/Lx2, 78K0/Lx3. μPD179F1xx: 4.8 μs, μPD78F0730: 5 μs, μPD78F071x: 70.83 μs
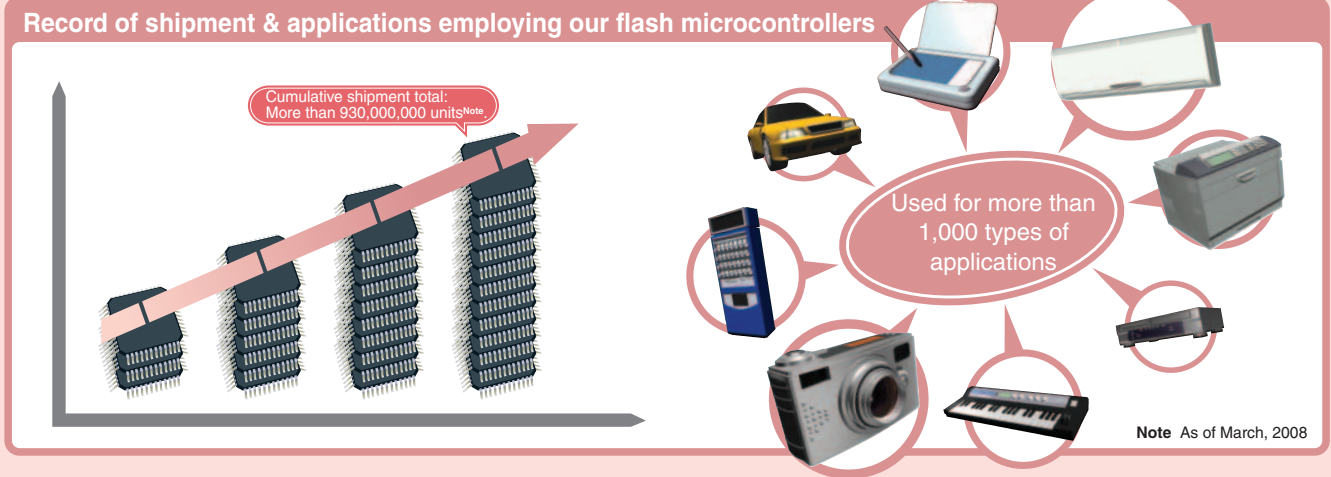*3  78K0/Kx2, 78K0/Lx2: When oscillation frequency is 10 MHz or less (AMPH = 0)
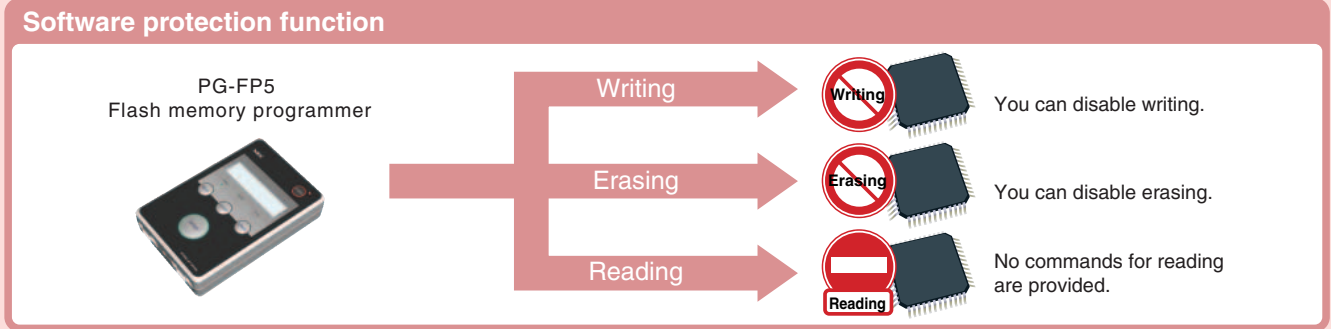
A  L  L   F  L  A  S  H

# High reliability

Side labels (left column): μPD78F0730, 78K0S/Kx1+, μPD179F1xx, 78K0/Kx2, 78K0/Lx2, 78K0/Lx3, μPD78F071x, 78K0/Kx2, 78K0/Lx2, 78K0/Lx3

**The reliability technologies developed for automotive flash microcontrollers can be found in all our flash microcontrollers, making them a safe choice.**
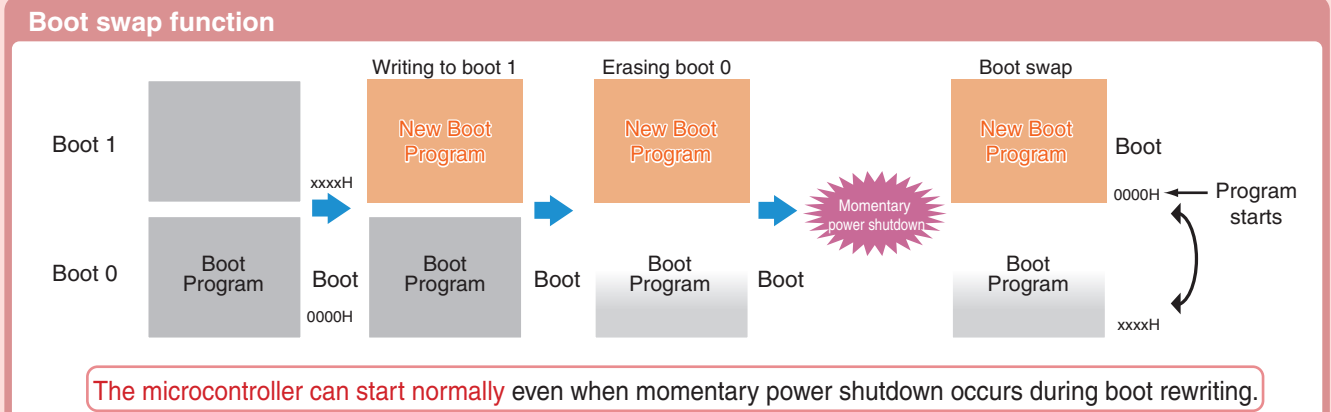
## Record of shipment & applications employing our flash microcontrollers

Cumulative shipment total:
More than 930,000,000 units[Note]

Used for more than 1,000 types of applications

**Note** As of March, 2008

**A flash security setting function is provided to protect your software from malicious rewriting and reading.**

## Software protection function

PG-FP5
Flash memory programmer

Writing → Writing → You can disable writing.

Erasing → Erasing → You can disable erasing.

Reading → Reading → No commands for reading are provided.

**A boot swap function is provided to protect important programs even when power shuts down during self-programming.**

## Problems during self-rewriting

Self-rewriting in progress → Momentary power shutdown → Operation is disabled. ?????

Power shutdown during self-rewriting may disable microcontroller recovery.

## Boot swap function

Writing to boot 1 — Erasing boot 0 — Boot swap

Boot 1 — New Boot Program — New Boot Program — New Boot Program

Boot 0 — Boot Program — Boot Program — Boot Program

xxxxH, 0000H

Momentary power shutdown

Boot, Program starts, 0000H, xxxxH

**The microcontroller can start normally** even when momentary power shutdown occurs during boot rewriting.

---

Side labels (right column): μPD78F071x, 78K0S/Kx1+, μPD78F0730, 78K0/Kx2, μPD179F1xx, 78K0/Lx2, 78K0/Lx3

**The enhanced watchdog timer (WDT) offers improved reliability and functionality equivalent to that of an external WDT.**

## WDT independent from CPU

Internal oscillation clock 240 kHz (TYP.) → WDT

Main clock → Independent from CPU → CPU peripheral functions

This configuration is the same as that in which an external watchdog timer is connected.
The WDT does not stop even if the main clock stops.

## WDT function

| | Conventional microcontrollers | 78K0/Kx2, 78K0/Lx2, 78K0/Lx3, and 78K0S/Kx1+ |
|---|---|---|
| X1 clock stops | The watchdog timer also stops and the microcontroller haywire cannot be detected. | The watchdog timer does not stop. |
| Microcontroller haywire | It is doubtful whether the haywire is detected because counts are cleared by 1-bit flags. | No need to worry about haywire because counts are cleared by the byte instruction. |

---

**The 78K0/Kx2, 78K0/Lx2, 78K0/Lx3, and μPD179F1xx have more reliable functions.**

## Window WDT

Outline of Window WDT

The Window WDT can detect infinite loops.
Clearance of WDT, Haywire

WDT starts counting
WDTE WDT Closes — WDTE WDT Opens — RESET Count overflow
RESET
Instruction for clearing the count
During the closure, clearance is rejected.
Time during which the counter can be cleared

Four types of Window settings can be selected according to the system.

- Quarter of Window opens.
- Half of Window opens.
- Three quarters of Window opens.
- Window fully opens (default).

---
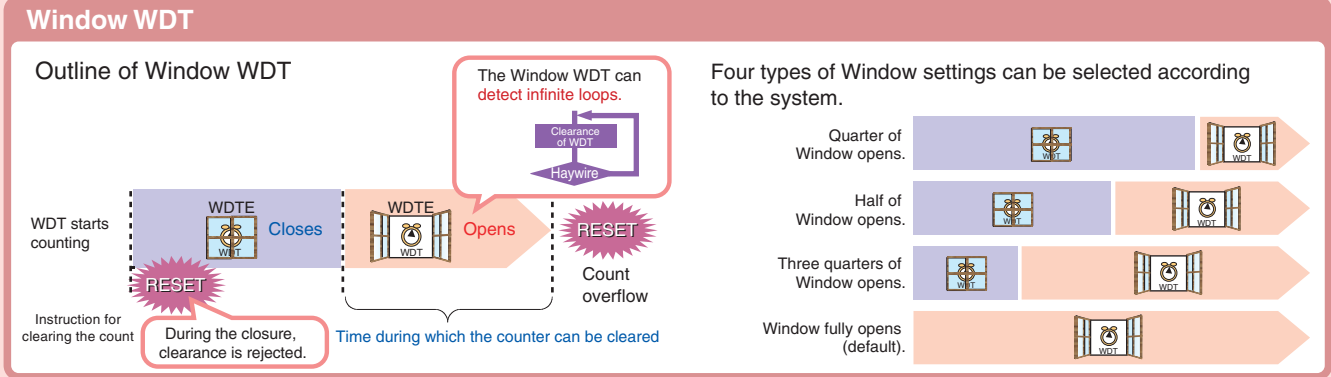
**An option byte function is incorporated to enable important system operation settings by hardware, eliminating setting errors caused by inadvertent program loops.**

## Option byte function

When RESET is released, you can set the setting value with the hardware.

ROM address
0080H

**78K0S/Kx1+**

| | | |
|---|---|---|
| Setting 1 | Low-speed internal oscillator oscillation | Stoppable/unstoppable by software |
| Setting 2 | Setting of system clock | High-speed internal oscillator/external resonator/external CLK |
| Setting 3 | Port setting of RESET pin | RESET/port |
| Setting 4 | Setting of wait time for oscillation stabilization | $2^{15}/fx$ to $2^{17}/fx$ |

**78K0/Kx2, 78K0/Lx2, 78K0/Lx3, μPD78F0730, μPD179F1xx**

| | | |
|---|---|---|
| Setting 1 | Low-speed internal oscillator oscillation | Stoppable/unstoppable by software |
| Setting 2 | Watchdog timer overflow time | 3.88 ms (TYP.) to 496.48 ms (TYP.) |
| Setting 3 | Watchdog timer window open time* | 25%/50%/75%/100% |

**μPD78F071x**

| | | |
|---|---|---|
| Setting 1 | Low-speed internal oscillator oscillation | Stoppable/unstoppable by software |

* This can be set to only 100% in the μPD78F0730.

# Rich development environment (1/2)

We provide inexpensive, easy-to-use, and convenient development environments, allowing you to select the best development environment according to the device and development conditions.

## Lineup of development environments

### Test board*4

| | Board supplied with Applilet® EZ for simple software creation | Starter kit for quick microcontroller programming | Test boards for MINICUBE2 | Pitch conversion board |
|---|---|---|---|---|
| **78K0S** | Applilet EZ / Microcontroller training kit<br><br>EZ-0001  ReferSTAR 78K*1 | For 20-pin SSOP package / For 20-pin DIP package<br><br>EZ-0002  CT-207*1 | For 78K0S/KB1+<br><br>QB-78K0SKB1-TB | DIP conversion board<br><br>FB-78F9222MC*2 |
| **78K0** | Microcontroller training kit<br><br>(ReferSTAR 78K upgrade kit*1) | For 78K0/KF2 / For 78K0/LG2<br><br>TK-78K0/KF2*3  EZ-0003 | For 78K0/KF2 / For 78K0/LG2<br><br>QB-78K0KF2-TB  QB-78K0LG2-TB<br>For 78K0/LF3<br><br>QB-78K0LF3-TB | |

## Development environment

Software development → Debugging/verification → Programming

### 78K0S

**Software development**
- Assembler (RA78K0S) (PM+ is included.) Compiler (CC78K0S)
- Device driver configurator (Applilet for 78K0S/Kx1+)
- Software package (SP78K0S)

**Debugging/verification**
- Simulator (SM+ for 78K0S/Kx1+)
- Full-function in-circuit emulator (IECUBE®)  QB-78K0SKX1
- On-chip debug emulator with flash programming function (MINICUBE2)  QB-MINI2

**Programming**
- Flash memory programmer  PG-FP5
- FL-PR5*2

### 78K0

**Software development**
- Assembler (RA78K0) (PM+ is included.) Compiler (CC78K0)
- Device driver configurator (Applilet2 for 78K0/Kx2) (Applilet2 for 78K0/Lx2)
- Software package (SP78K0)

**Debugging/verification**
- Simulator (SM+ for 78K0/Kx2)*4
- Full-function in-circuit emulator (IECUBE)  QB-78K0KX2 / QB-78K0LX2 / QB-78K0LX3 / QB-780714 / QB-780731 / QB-179F124
- On-chip debug emulator with flash programming function (MINICUBE2)  QB-MINI2

**Programming**
- Flash memory programmer  PG-FP5
- FL-PR5*2

*1 Made by Sunhayato Corporation
*2 Made by Naito Densei Machida Mfg. Co., Ltd.
*3 Made by Application Corporation
*4 Not supported by the μPD179F1xx.

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## Development flow

### Example of inexpensive development environment

78K0S/Kx1+ | 78K0/Kx2 | 78K0/Lx2 | 78K0/Lx3

**Test boards**

QB-78K0SKB1-TB  QB-78K0KF2-TB  QB-78K0LG2-TB  QB-78K0LF3-TB



Connected to universal board for easy evaluation.

On-chip debug emulator with flash programming function MINICUBE2

Create software with Applilet*1, assembler/compiler, and device file. → Perform debugging with a simulator (SM+)*1. → Perform programming with MINICUBE2.

### I need software tools.

**All the required software is available in one package.**

Software packages (SP78K0S, SP78K0)
The software package includes the following.
- Assembler package
  - Assembler
  - Linker
  - Object converter
  - Librarian
  - List converter
  - Structured assembler preprocessor
- PM+
- C compiler
- Integrated debugger*2

System simulators (SM+ for 78K0S/Kx1+, SM+ for 78K0/Kx2)

**Remark** The assembler package, C compiler, and integrated debugger are also sold separately.

### I want to perform debugging with the microcontroller connected to the target board.

**A simplified emulator is also available.**

MINICUBE2 (On-chip debug emulator with flash programming function)
- QB-MINI2
  (78K0S/Kx1+, 78K0/Kx2, 78K0/Lx2 78K0/Lx3, μPD78F071x, μPD78F0730, μPD179F1xx supported)

**A full-function emulator is also available.**

IECUBE (Full-function in-circuit emulator)
- QB-78K0SKX1 (For 78K0S/Kx1+)
- QB-78K0KX2 (For 78K0/Kx2)
- QB-78K0LX2 (For 78K0/Lx2)
- QB-78K0LX3 (For 78K0/Lx3)
- QB-780714 (For μPD78F071x)
- QB-780731 (For μPD78F0730)
- QB-179F124 (For μPD179F1xx)

### I want a programmer that can be used with all flash microcontrollers.

**Programmers suited to your needs are also available.**

PG-FP5
NEC Electronics

FL-PR5*3
Partner manufacturer

*1 Not supported by the μPD179F1xx.
*2 ID78K0S-NS only. The ID78K0S-QB and ID78K0-QB are supplied with an emulator.
*3 Made by Naito Densei Machida Mfg. Co., Ltd.

For details on tools, access these URLs. → **http://www.necel.com/micro/eng/freesoft/index.html**

Vertical side tabs (left): 78K0S/Kx1+ | 78K0/Kx2 | 78K0/Lx2 | 78K0/Lx3 | μPD78F071x | μPD78F0730 | μPD179F1xx

## Hardware tool

### Full-function emulator

#### IECUBE (Full-function in-circuit emulator)

System configuration



MINICUBE2 (On-chip debug emulator with flash programming function)

(Used for programming)

IECUBE 78K0S/Kx1+

IECUBE 78K0/Kx2, 78K0/Lx2, 78K0/Lx3, μPD78F071x, μPD78F0730, μPD179F1xx

USB cable

CD-ROM (Integrated debugger, etc.)

Host PC

Power supply

Target cable (30 single wires)

Device

Recommended target pin header
Specification  Width   0.635 mm
              Breadth 0.635 mm
              Height  6 mm

Target system

**<1> Check pin adapter**
Adapter used for waveform observation with an oscilloscope, etc.

**<2> Emulation probe**
Flexible-type emulation probe (78K0S/Kx1+, 78K0/Kx2, 78K0/Lx3, μPD78F071x, μPD78F0730, μPD179F1xx)
Coaxial-type emulation probe (78K0/Lx2)

**<3> Exchange adapter**
Adapter that is used for pin conversion from IECUBE to the target connector according to the type of device
Ⓐ For 10-pin and 16-pin products
Ⓑ For 20-pin and 30-pin products

**<4> Space adapter**
Adapter that adjusts the difference between the height of the target system and that of IECUBE, if necessary

**<5> Mount adapter**
Adapter for mounting microcontrollers

**<6> YQ connector**
Conversion adapter that connects the target connector to the exchange adapter

**<7> Target connector**
Connector for mounting the microcontroller on the target system
Ⓐ For 10-pin and 16-pin products
Ⓑ For 20-pin and 30-pin products

IECUBE accessories
Required [*1]
Optional [*2]

*1 Options required for connecting target system when using IECUBE for 78K0/Kx2, 78K0/Lx2, 78K0/Lx3, μPD78F071x, μPD78F0730, and μPD179F1xx microcontrollers
Options required for attaching with attachment pad of target device when using 78K0S/Kx1+ microcontroller
*2 Options required to meet debug application needs when using IECUBE for 78K0/Kx2, 78K0/Lx2, 78K0/Lx3, μPD78F071x, μPD78F0730, and μPD179F1xx microcontrollers

**Remark** For the device development environment when using IECUBE, see the **Single-Chip Microcontroller Development Tools Selection Guide (U11069E)**.

### Flash memory programmer

| Product Name | Package Contents |
|---|---|
| **PG-FP5 (flash memory programmer)** | PG-FP5 main unit, USB cable, serial cable, power supply cable, target cable, and ground cable |

### Simplified emulator

#### MINICUBE2 (On-chip debug emulator with flash programming function)



Target cable

MINICUBE2 (On-chip debug emulator with flash programming function)

Web [*1] (Integrated debugger etc.)

USB cable

Host PC

78K0-OCD board [*2]

Target system

MINICUBE2 accessories

Recommended connectors
• HIF3FC-16PA-2.54DS (manufactured by Hirose Electric Co., Ltd., right-angle product)
• HIF3FC-16PA-2.54DSA (manufactured by Hirose Electric Co., Ltd., straight-angle product)
• 7616-5002PL (manufactured by Sumitomo 3M Ltd., right-angle product)
• 7616-6002PL (manufactured by Sumitomo 3M Ltd., straight-angle product)

*1 For more information on MINICUBE2:
http://www.necel.com/micro/en/development/asia/minicube2/minicube2.html
*2 MINICUBE2 accessory required for on-chip debugging of 78K0 microcontrollers

## Software tool

Vertical side tabs (right): 78K0S/Kx1+ | 78K0/Kx2 | 78K0/Lx2 | 78K0/Lx3 | μPD78F071x | μPD78F0730 | μPD179F1xx

| Commercial Name | Package | Software Package | C Compiler Package | Assembler Package | Integrated Debugger | System Simulator | Device File |
|---|---|---|---|---|---|---|---|
| **78K0S/KU1+** | 10-pin SSOP (5.72 mm (225)) | SP78K0S [*2] | CC78K0S | RA78K0S | ID78K0S-QB | SM+ for 78K0S/Kx1+ [*4] | DF789234 |
| **78K0S/KY1+** | 16-pin SDIP (7.62 mm (300)) | | | | | | |
| | 16-pin SSOP (5.72 mm (225)) | | | | | | |
| | 16-pin WLBGA (2 × 2.3 mm) | | | | | | |
| **78K0S/KA1+** | 20-pin SDIP (7.62 mm (300)) | | | | | | |
| | 20-pin SSOP (7.62 mm (300)) | | | | | | |
| | 20-pin WLBGA (2.1 × 2.6 mm) [*1] | | | | | | |
| **78K0S/KB1+** | 30-pin SSOP (7.62 mm (300)) | | | | | | |
| | 32-pin SDIP (7.62 mm (300)) | | | | | | |
| **78K0/KB2** | 30-pin SSOP (7.62 mm (300)) | SP78K0 [*3] | CC78K0 | RA78K0 | ID78K0-QB | SM+ for 78K0/Kx2 | DF780547 |
| | 36-pin FLGA (4 × 4 mm) | | | | | | |
| **78K0/KC2** | 38-pin SSOP (7.62 mm (300)) | | | | | | |
| | 44-pin LQFP (10 × 10 mm) | | | | | | |
| | 48-pin LQFP (7 × 7 mm) | | | | | | |
| **78K0/KD2** | 52-pin LQFP (10 × 10 mm) | | | | | | |
| **78K0/KE2** | 64-pin LQFP (14 × 14 mm) | | | | | | |
| | 64-pin LQFP (12 × 12 mm) | | | | | | |
| | 64-pin LQFP (10 × 10 mm) | | | | | | |
| | 64-pin TQFP (7 × 7 mm) | | | | | | |
| | 64-pin FLGA (5 × 5 mm) | | | | | | |
| | 64-pin FPBGA (4 × 4 mm) [*1] | | | | | | |
| **78K0/KF2** | 80-pin LQFP (14 × 14 mm) | | | | | | |
| | 80-pin LQFP (12 × 12 mm) | | | | | | |
| **μPD179F1xx** | 30-pin SSOP (7.62 mm (300)) | | | | | | DF179124 |
| | 38-pin SSOP (7.62 mm (300)) | | | | | | |
| **μPD78F0730** | 30-pin SSOP (7.62 mm (300)) | | | | | | DF780731 |
| **μPD78F071x** | 30-pin SSOP (7.62 mm (300)) | | | | | | DF780141 |
| | 64-pin LQFP (12 × 12 mm) | | | | | | |
| **78K0/LE2** | 64-pin LQFP (12 × 12 mm) | | | | | | DF780397 |
| | 64-pin LQFP (10 × 10 mm) | | | | | | |
| **78K0/LF2** | 80-pin LQFP (14 × 14 mm) | | | | | | |
| | 80-pin LQFP (12 × 12 mm) | | | | | | |
| **78K0/LG2** | 100-pin LQFP (14 × 14 mm) | | | | | | |
| **78K0/LC3** | 48-pin LQFP (7 × 7 mm) | | | | | | DF780495 |
| **78K0/LD3** | 52-pin LQFP (10 × 10 mm) | | | | | | |
| **78K0/LE3** | 64-pin LQFP (12 × 12 mm) [*1] | | | | | | |
| | 64-pin LQFP (10 × 10 mm) [*1] | | | | | | |
| **78K0/LF3** | 80-pin LQFP (14 × 14 mm) [*1] | | | | | | |
| | 80-pin LQFP (12 × 12 mm) [*1] | | | | | | |

*1 Under development    *2 The CC78K0S and RA78K0S are packaged in the SP78K0S.
*3 The CC78K0 and RA78K0 are packaged in the SP78K0.    *4 The 78K0S/KU1+ is not supported. Support is planned with the next upgrade.

# Support for mass production

**Mass production support environment for your needs.**
**You can select the mass production method with the largest merit, according to delivery time or mass production quantity.**

## Programming by the customer

### Delivery time[*1]: Practically none, highly flexible

#### Support for introducing in-line programming

Support for introducing programming processes to production line

**Naito Densei Machida Mfg. Co., Ltd.**
**Yokogawa Digital Computer Corporation**

Customizing programmer GUIs

Unprogrammed products received

ALL FLASH

Mount  Test and program  Completion

Plant line

**Consultation for introduction of programming processes**

#### Flash memory programmers

Various products selectable for your purposes and price range

| **PG-FP5** | **FL-PR5** | **NET IMPRESS series\*** | **Y3000-8\*** | **ITF-2000\*** | **Stick GANG Writer\*** | **StickWriter\*** |
| NEC Electronics | Naito Densei Machida Mfg. Co., Ltd. | Yokogawa Digital Computer Corporation | Wave Technology Co., Ltd. | Interface Co., Ltd. | Application Corporation | Application Corporation |

\* Compatibilities differ according to product.

## Programming by partner companies

**Flexible support for small-volume programming and short delivery time**

### Programming houses

Just ask us about the programming houses in your region

Synchroworks Corporation  TSC TAKUMI SHOJI CO.,LTD
Matsubara.KK  ARROW GLOBAL PROGRAMMING SERVICES  ROHITEC  LIBERTY
ertec  Gleichmann Electronics  SOURCE Technical Engineer  TELFORD

## Programmed products

**Shipment form same as that of mask ROM microcontrollers**

### NEC Electronics

The same way as mask ROM microcontrollers, programmed products can be delivered with a short TAT

**NEC** NEC Electronics

ALL FLASH

**Submitting software**  **Programming**  **Shipment**

### Programming houses

Delivery time[*1]: **Several days**

### NEC Electronics

Delivery time[*1]: **About 1/2 that of mask ROM**[*2]

**Delivery**

Order  ALL FLASH  All Flash microcontrollers  **Mass production**

Order  ALL FLASH  All Flash microcontrollers

Order  Conventional mask ROM microcontrollers

From ordering to delivery time for mass production start schedule

**\*1.** Period from completion of software until start of mass production
**\*2.** Delivery time may vary depending on purchase conditions, such as order quantity.

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# Application examples

**Various functions achieved with 78K0 All Flash features and libraries**
**New functions can be easily constructed. One example is introduced below.**

## Speaking (ADPCM: Adaptive Differential Pulse Code Modulation)

**A voice function can be realized without a dedicated IC! Contributes to reduced costs.**

ADPCM library[*1] + Voice data[*2]

Internal flash  Internal RAM  PWM

• Filter • Amplifier  Speaker

**Application example**

Fire!

Fire alarm system

**\*1. ADPCM library (ADPCM-SP2) features**

| Software sizes | | Extension processing performance (during 20 MHz drive) |
| ROM | RAM | |
| 600 bytes | 8 bytes | 17 µs, max. |

Cautions 1. The above processing times are processing times for individual libraries. When mounted in a system, this becomes a total of 40 µs (during 20 MHz drive), because extra processing time is required for output processing.
2. Processing is necessary every 125 µs in the case of 8 kHz sampling voice.

**\*2. Voice data compression can be chosen from 2 patterns.**

| Compression rate | High audio quality → High compression | |
| | 4 KBps | 2 KBps |

### Evaluation environment to support "speaking"

**Voice conversion tool (WAVE→ADPCM)**

TK-78K0/KF2+Voice
Made by Application Corporation

CvADPCM
Made by NEC Electronics Corporation
Obtained from our Website

## Connecting (ZigBee®)

**The ZigBee 2006 Standard is already applied! Development can start right away.**

Network example

Smoke detector
Air conditioning
Home controller (coordinator)
Coordinator for intrusion sensors
Open/close status sensor
Electricity meter reading
Backbone networks
Temperature/humidity sensor
Vibration sensors

| HVAC | FIRE & SECURITY | ENERGY SAVING AMR | OTHERS |
| Thermostats Temp sensors Heating timers Air conditioning | Smoke detectors Fire alarms Intrusion sensors Glass break sensor | Lighting dimmers Lighting ballast PIR sensors | Medical Asset management Remote controls Industrial process |

**TK-850/SG2 + UZ[*1] (UZ2400 mounted)**
32-bit microcontroller V850ES/SG2 mounted
- Internal ROM: 384 KB
- Internal RAM: 32 KB

**TK-78K0R/KG3 + UZ[*1] (UZ2400 mounted)**
16-bit microcontroller 78K0R/KG3 mounted
- Internal ROM: 512 KB
- Internal RAM: 30 KB

**TK-78K0/KF2 + UZ[*1] (UZ2400 mounted)**
8-bit microcontroller 78K0/KF2 mounted
- Internal ROM: 128 KB
- Internal RAM: 7 KB

### ZigBee SDK[*2] (software development kit)

A protocol stack library that enables peer-to-peer connection by using the GUI on the PC screen, establishment of Mesh net wireless communication, diagnosis, and debugging, is included.
- ZigBee 2006 Standard applied

\*1 Made by Application Corporation
\*2 Product co-developed by Skyley Networks, Inc. and NEC Electronics.

## CPU Core

| | 78K0S | | | | 78K0 | | | | | 78K0 | 78K0 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Commercial name** | 78K0S/KU1+ | 78K0S/KY1+ | 78K0S/KA1+ | 78K0S/KB1+ | 78K0/KB2 | 78K0/KC2 | 78K0/KD2 | 78K0/KE2 | 78K0/KF2 | µPD179F1xx | µPD78F0730 |
| **Pin count** | 10-pin | 16-pin | 20-pin | 30/32-pin | 30/36-pin | 38-pin*1 / 44-pin / 48-pin | 52-pin | 64-pin | 80-pin | 30-pin / 38-pin | 30-pin |
| **Product name** | µPD78F9200, µPD78F9201, µPD78F9202 | µPD78F9500, µPD78F9501, µPD78F9502, µPD78F9210, µPD78F9211, µPD78F9212, µPD78F9510, µPD78F9511, µPD78F9512 | µPD78F9221, µPD78F9222 | µPD78F9232, µPD78F9234 | µPD78F0500A, µPD78F0501A, µPD78F0502A, µPD78F0503A | µPD78F0511A, µPD78F0512A, µPD78F0513A / µPD78F0511A, µPD78F0512A, µPD78F0513A / µPD78F0511A, µPD78F0512A, µPD78F0513A, µPD78F0514A, µPD78F0515A | µPD78F0521A, µPD78F0522A, µPD78F0523A, µPD78F0524A, µPD78F0525A, µPD78F0526A, µPD78F0527A | µPD78F0531A, µPD78F0532A, µPD78F0533A, µPD78F0534A, µPD78F0535A, µPD78F0536A, µPD78F0537A | µPD78F0544A, µPD78F0545A, µPD78F0546A, µPD78F0547A | µPD179F-F110, F111, F112, F113, F114 / µPD179F-F122, F123, F124 | µPD78F0730 |
| **Flash memory (bytes)** | 1 K, 2 K, 4 K | 1 K, 2 K, 4 K, 1 K, 2 K, 4 K, 1 K, 2 K, 4 K | 2 K, 4 K | 4 K, 8 K | 8 K, 16 K, 24 K, 32 K | 16 K, 24 K, 32 K / 16 K, 24 K, 32 K / 16 K, 24 K, 32 K, 48 K, 60 K | 16 K, 24 K, 32 K, 48 K, 60 K, 96 K, 128 K | 16 K, 24 K, 32 K, 48 K, 60 K, 96 K, 128 K | 48 K, 60 K, 96 K, 128 K | 4 K, 8 K, 16 K, 24 K, 32 K / 16 K, 24 K, 32 K | 16 K |
| **Bank** | – | – | – | – | – | – | 4, 6 | 4, 6 | 4, 6 | – | – |
| **RAM (bytes)** | 128 | 128 | 128, 256 | 256 | 512, 768, 1 K, 1 K | 768, 1 K, 1 K / 768, 1 K, 1 K / 768, 1 K, 1 K | 768, 1 K, 1 K, 2 K, 3 K, 5 K, 7 K | 768, 1 K, 1 K, 2 K, 3 K, 5 K, 7 K | 2 K, 3 K, 5 K, 7 K | 512, 512, 768, 1 K, 1 K / 768, 1 K, 1 K | 3 K |

### Power supply voltage

| Mode | 78K0S | 78K0 (KB2–KF2) | µPD179F1xx | µPD78F0730 |
|---|---|---|---|---|
| Normal operation mode | 2.0 to 5.5 V | 1.8 to 5.5 V | 1.8 to 3.6 V | 4.0 to 5.5 V |
| Flash memory programming mode | 2.7 to 5.5 V | 2.7 to 5.5 V | 2.0 to 3.6 V | 4.0 to 5.5 V |

**Minimum instruction execution time**
- 78K0S: 0.20 µs (10 MHz: $V_{DD}$ = 4.0 to 5.5 V)/0.33 µs (6 MHz: $V_{DD}$ = 3.0 to 5.5 V)/0.40 µs (5 MHz: $V_{DD}$ = 2.7 to 5.5 V)/1.0 µs (2 MHz: $V_{DD}$ = 2.0 to 5.5 V)
- 78K0: 0.10 µs (20 MHz: $V_{DD}$ = 4.0 to 5.5 V)/0.20 µs (10 MHz: $V_{DD}$ = 2.7 to 5.5 V)/0.40 µs (5 MHz: $V_{DD}$ = 1.8 to 5.5 V)
- µPD179F1xx: 0.5 µs (4 MHz: $V_{DD}$ = 2.0 to 3.6 V)/1 µs (2 MHz: $V_{DD}$ = 1.8 to 3.6 V)
- µPD78F0730: 0.125 µs (16 MHz: $V_{DD}$ = 4.0 to 5.5 V)

### Clock

| | 78K0S | 78K0 | µPD179F1xx | µPD78F0730 |
|---|---|---|---|---|
| Main clock – High-speed system clock | Ceramic*2/crystal*2/external clock: 1 to 10 MHz | Ceramic/crystal/external clock: 1 to 20 MHz | Ceramic/crystal/external clock: 1 to 4 MHz | *5 |
| High-speed internal oscillator | 8 MHz ±5% | 8 MHz ±5% | 4 MHz ±2% | 16 MHz ±10% |
| Sub-clock | – | Crystal/external clock: 32.768 kHz | – | – |
| Low-speed internal oscillator | 240 kHz (TYP.) (watchdog timer and clock for 8-bit timer TMH1) | 240 kHz ±10% (watchdog timer and clock for 8-bit timer TMH1) | 240 kHz (TYP.) (watchdog timer and clock for 8-bit timer TMH1) | *6 |

### I/O ports

| | KU1+ | KY1+ | KA1+ | KB1+ | KB2 | KC2 (38/44/48) | KD2 | KE2 | KF2 | 179F1xx (30/38) | 78F0730 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Total | 8 | 14 | 17 | 26 | 23 | 31 / 37 / 41 | 45 | 55 | 71 | 26 / 34 | 19 |
| CMOS I/O | 7 | 13 | 15 | 24 | 21 | 29 / 33 / 37 | 40 | 50 | 66 | 25 / 33 | 17 |
| CMOS input | 1 | 1 | 1 | 1 | – | – | – | – | – | 1 / 1 | – |
| CMOS output | – | – | 1 | 1 | – | – | 1 | 1 | 1 | – / – | – |
| N-ch open-drain | – | – | – | – | 2 | 4 | 4 | 4 | 4 | N-ch: 24, P-ch: 1*3 / N-ch: 32, P-ch: 1*3 | 2 |

### Timer

| | KU1+ | KY1+ | KA1+ | KB1+ | KB2 | KC2 | KD2 | KE2 | KF2 | 179F1xx | 78F0730 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 16-bit timer (TM0) – Number of channels | 1 | – | 1 | 1 | 1 | 1 | 1 | 1, 2 | 2 | 1 | 1 |
| 8-bit timer (TMH) – Number of channels | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 1 |
| 8-bit timer (TM5) – Number of channels | – | – | – | – | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| 8-bit timer (TM8) – Number of channels | – | – | 1 | 1 | – | – | – | – | – | – | – |
| Watchdog timer (WDT) | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Watch timer | – | – | – | – | – | 1 | 1 | 1 | 1 | – | – |
| Real-time counter (RTC) | – | – | – | – | – | – | – | – | – | – | – |

**Function (16-bit timer TM0):** Interval timer/external event counter/PPG output/pulse width measurement/square-wave output/one-shot pulse output

**Function (8-bit timer TMH):** 78K0S: Interval timer/PWM output/square-wave output; 78K0 & 179: Interval timer/PWM output/carrier generator output/square-wave output

**Function (8-bit timer TM5):** Interval timer/external event counter/PWM output/square-wave output

**Function (8-bit timer TM8):** Interval timer

### Serial interface

| | KU1+ | KY1+ | KA1+ | KB1+ | KB2 | KC2 | KD2 | KE2 | KF2 | 179F1xx | 78F0730 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| UART (supporting LIN) | – | – | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 (not supporting LIN) | 1 (not supporting LIN) |
| UART/CSI | – | – | – | – | 1 | 1 | 1 | 1 | 1 | – | – |
| CSI | – | – | – | – | – | – | – | 1 | 1 | – | 1 |
| Automatic transmit/receive 3-wire CSI | – | – | – | – | – | – | – | – | 1 | – | – |
| I²C | – | – | – | – | 1 | 1 | 1 | 1 | 1 | – | – |

### A/D converter

| | KU1+ | KY1+ | KA1+ | KB1+ | KB2 | KC2 | KD2 | KE2 | KF2 | 179F1xx | 78F0730 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Successive approximation (10-bit) | 4 | – | 4 | 4 | 4 | 6 / 8 / 8 | 8 | 8 | 8 | 8 | – |
| ΔΣ (16-bit) | – | – | – | – | – | – | – | – | – | – | – |

### Interrupt

| | KU1+ | KY1+ | KA1+ | KB1+ | KB2 | KC2 | KD2 | KE2 | KF2 | 179F1xx | 78F0730 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| External | 2 | 2 | 4 | 4 | 6 | 7 / 7 / 8 | 8 | 9 | 9 | 8 | 4 |
| Internal | 5, 3 | 5, 4 | 9 | 9 | 14 | 16 | 16 | 16, 19 | 20 | 10 | 14 |

### Maximum number of segments displayed in LCD

| 8 commons | – (all) |
|---|---|
| 4 commons | – (all) |

### Other

| | 78K0S | KB2 | KC2 | KD2 | KE2 | KF2 | 179F1xx | 78F0730 |
|---|---|---|---|---|---|---|---|---|
| On-chip debug (MINICUBE2) | Supported | – | Supported*4 | Supported*4 | Supported*4 | Supported*4 | Supported | Supported |
| Multiplier/divider | – (KB1+: 8-bit × 8-bit) | – | 16-bit × 16-bit, 32-bit ÷ 16-bit | 16-bit × 16-bit, 32-bit ÷ 16-bit | 16-bit × 16-bit, 32-bit ÷ 16-bit | 16-bit × 16-bit, 32-bit ÷ 16-bit | – | – |
| Power-on clear (POC) | 2.1 V ±0.1 V | 1.59 V ±0.15 V | 1.59 V ±0.15 V | 1.59 V ±0.15 V | 1.59 V ±0.15 V | 1.59 V ±0.15 V | 1.8 V ±0.1 V | 1.59 V ±0.15 V |
| Other | – | – | – | Clock output | Clock output | Clock output, buzzer output | – | *8 |

**Low voltage detector (LVI)**
- 78K0S: 2.35/2.6 V ±0.1 V or 2.85/3.1/3.3 V ±0.15 V or 3.5/3.7/3.9/4.1/4.3 V ±0.2 V (Selectable by software)
- 78K0: 1.93/2.08/2.24/2.39/2.55/2.70/2.85/3.01/3.16/3.32/3.47/3.62/3.78/3.93/4.09/4.24 V (default) ±0.1 V, The detected voltage can be input to pins. (Selectable by software)
- µPD179F1xx: 2.08 V $^{+0.07}_{-0.08}$ V, 1.93 to 3.47 V ±0.1 V, The detected voltage can be input to pins. (Selectable by software)
- µPD78F0730: *7

**Operating temperature**
- 78K0S: $T_A$ = –40 to +85°C (model with expanded temperature range)
- 78K0: $T_A$ = –40 to +85°C (model with expanded temperature range planned)
- µPD179F1xx / µPD78F0730: $T_A$ = –40 to +85°C

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*1. The µPD78F0511A (38-pin), µPD78F0512A (38-pin), µPD78F0513A (38-pin), and µPD78F0513DA (38-pin) are under development.
*2. The µPD78F9500, 78F9501, and 78F9502 cannot connect to a ceramic or crystal resonator.
*3. N-ch open-drain output and P-ch open-drain output are alternatively used as CMOS I/O.
*4. Only supported in the µPD78F0503DA, 78F0513DA, 78F0515DA, 78F0527DA, 78F0537DA, and 78F0547DA.
**Remark** The specifications of products still under development or in planning are subject to change without notice.

*5. Ceramic/crystal/external clock: 12/16 MHz
*6. 240 kHz ±10% (watchdog timer and clock for 8-bit timer TMH1)
*7. 4.24 V ±0.1 V or 4.09 V ±0.1 V (selectable by software)
*8. USB2.0 full-speed function controller

| CPU Core | | 78K0 | 78K0 | | | | 78K0 | | |
|---|---|---|---|---|---|---|---|---|---|
| Commercial name | | μPD78F071x | 78K0/LC3 | 78K0/LD3 | 78K0/LE3 | 78K0/LF3 | 78K0/LE2 | 78K0/LF2 | 78K0/LG2 |
| Pin count | | 30-pin / 64-pin | 48-pin | 52-pin | 64-pin | 80-pin | 64-pin | 80-pin | 100-pin |
| Product name | | μPD78F0711, 0712, 0714 | μPD78F0400–0413 | μPD78F0420–0433 | μPD78F0441–0445, 0451–0455, 0461[*1]–0465[*1] | μPD78F0471–0475, 0481–0485, 0491[*1]–0495[*1] | μPD78F0361–0363 | μPD78F0372–0376, 0382–0386 | μPD78F0393–0397 |

| | | μPD78F071x | 78K0/LC3 | 78K0/LD3 | 78K0/LE3 | 78K0/LF3 | 78K0/LE2 | 78K0/LF2 | 78K0/LG2 |
|---|---|---|---|---|---|---|---|---|---|
| Flash memory (bytes) | | 8 K, 16 K, 32 K | 8 K, 16 K, 24 K, 32 K | 8 K, 16 K, 24 K, 32 K | 8 K, 16 K, 24 K, 32 K, 48 K, 60 K | 16 K, 24 K, 32 K, 48 K, 60 K | 16 K, 24 K, 32 K | 24 K, 32 K, 48 K, 60 K, 96 K | 32 K, 48 K, 60 K, 96 K, 128 K |
| | Bank | – – – | – | – | – | – | – | – 4 | – 4 6 |
| RAM (bytes) | | 768, 768, 1 K | 512, 768, 1 K, 1 K | 512, 768, 1 K, 1 K | 512, 768, 1 K, 1 K, 2 K, 2 K | 768, 1 K, 1 K, 2 K, 2 K | 768, 1 K, 1 K, 2 K | 1 K, 1 K, 1 K, 2 K, 3 K, 5 K | 1 K, 2 K, 3 K, 5 K, 7 K |
| Power supply voltage | Normal operation mode | 4.0 to 5.5 V | 1.8 to 5.5 V | | | | 1.8 to 5.5 V | | |
| | Flash memory programming mode | 4.0 to 5.5 V | 2.7 to 5.5 V | | | | 2.7 to 5.5 V | | |
| Minimum instruction execution time | | 0.10 μs (20 MHz: $V_{DD}$ = 4.0 to 5.5 V) | 0.20 μs (10 MHz: $V_{DD}$ = 2.7 to 5.5 V)/0.40 μs (5 MHz: $V_{DD}$ = 1.8 to 5.5 V) | | | | 0.10 μs (20 MHz: $V_{DD}$ = 4.0 to 5.5 V)/0.20 μs (10 MHz: $V_{DD}$ = 2.7 to 5.5 V)/0.40 μs (5 MHz: $V_{DD}$ = 1.8 to 5.5 V) | | |
| Clock | Main clock – High-speed system clock | Ceramic/crystal/external clock: 5 to 20 MHz | Ceramic/crystal/external clock: 2 to 10 MHz | | | | Ceramic/crystal/external clock: 1 to 20 MHz | | |
| | Main clock – High-speed internal oscillator | 8 MHz ±5 % – | 8 MHz ±5% | | | | 8 MHz ±5% | | |
| | Sub-clock | – | Crystal: 32.768 kHz | | | | Crystal/external clock: 32.768 kHz | | |
| | Low-speed internal oscillator | 240 kHz | 240 kHz ±10% (watchdog timer and clock for 8-bit timer TMH1) | | | | 240 kHz ±10% (watchdog timer and clock for 8-bit timer TMH1) | | |
| I/O ports | Total | 15 48 | 30 | 34 | 46 | 62 | 24 | 34 | 26 40 |
| | CMOS I/O | 11 40 | 26 | 30 | 42 | 58 | 24 | 34 | 26 40 |
| | CMOS input | 4 8 | 4 | 4 | 4 | 4 | – | – | – |
| | CMOS output | – | – | – | – | – | – | – | – |
| | N-ch open-drain | – | – | – | – | – | – | – | – |
| Timer | 16-bit timer (TM0) – Number of channels | 1 | 1 | 1 | 1 | 1 | 1 1 2 | 1 2 | 1 2 |
| | 16-bit timer (TM0) – Function | | Interval timer/external event counter/pulse width measurement/square-wave output/one-shot pulse output[*2] / PPG output | | | | Interval timer/external event counter/PPG output/pulse width measurement/square-wave output/one-shot pulse output | | |
| | 8-bit timer (TMH) – Number of channels | – 1 | 3 | 3 | 3 | 3 | 2 2 | 2 | 2 |
| | 8-bit timer (TMH) – Function | | Interval timer/PWM output/carrier generator output /square-wave output | | | | Interval timer/PWM output/carrier generator output/square-wave output | | |
| | 8-bit timer (TM5) – Number of channels | 2 | 3 | 3 | 3 | 3 | 2 2 | 2 | 2 |
| | 8-bit timer (TM5) – Function | | Interval timer/external event counter/PWM output/square-wave output[*2] | | | | Interval timer/external event counter/PWM output/square-wave output | | |
| | 8-bit timer (TM8) – Number of channels | – | – | – | – | – | – | – | – |
| | 8-bit timer (TM8) – Function | – | – | – | – | – | – | – | – |
| | Watchdog timer (WDT) | 1 | 1 | 1 | 1 | 1 | 1 1 | 1 | 1 |
| | Watch timer | – | – | – | – | – | 1 1 | 1 | 1 |
| | Real-time counter (RTC) | – | 1 | 1 | 1 | 1 | – | – | – |
| Serial interface | UART (supporting LIN) | 1 (not supporting LIN) | 2[*3] | 1 | 1 | 1 | 1 1 | 1 | 1 |
| | UART/CSI | – | – | 1 | 1 | 1 | 1 1 | 1 | 1 |
| | CSI | – 1 | – | – | – | – | – | – | – 1 |
| | Automatic transmit/receive 3-wire CSI | – | – | – | – | 1 | – | – | – |
| | I²C | – | – | – | – | – | 1 1 | 1 | 1 |
| A/D converter | Successive approximation (10-bit) | 4 8 | – 6 | – 6 | – 8 | 8 – | 5 8 | – | 8 |
| | ΔΣ (16-bit) | – | – – | – – | – – | 3 – | – 3 | – | – |
| Interrupt | External | 5 8 | 5 | 5 | 6 | 7 | 6 7 7 | 7 7 | 7 7 |
| | Internal | 14 20 | 17 18 | 19 20 | 19 20 21 | 20 21 22 | 16 16 18 | 15 17 | 16 19 |
| Maximum number of segments displayed in LCD | 8 commons | – | 144 | 160 | 224 224 | 160 288 | 288 224 | – | – – – |
| | 4 commons | – | 88 | 96 | 128 128 | 96 160 | 160 128 | 80 104 | 144 160 |
| On-chip debug (MINICUBE2) | | Supported | Supported | | | | – Supported[*6] – Supported[*6] – Supported[*6] | | – Supported[*6] |
| Multiplier/divider | | 16-bit × 16-bit, 32-bit ÷ 16-bit | – | – | – | – | – – 16-bit × 16-bit, 32-bit ÷ 16-bit | 16-bit × 16-bit, 32-bit ÷ 16-bit – | 16 bit × 16-bit, 32 bit ÷ 16-bit |
| Low voltage detector (LVI) | | 4.3 V ±0.2 V | 1.93/2.08/2.24/2.39/2.55/2.70/2.85/3.01/3.16/3.32/3.47/ 3.62/3.78/3.93/4.09/4.24 V (default) ±0.1 V, The detected voltage can be input to pins. (Selectable by software) | | | | 1.93/2.08/2.24/2.39/2.55/2.70/2.85/3.01/3.16/3.32/3.47/3.62/3.78/3.93/4.09/4.24 V (default) ±0.1 V, The detected voltage can be input to pins. (Selectable by software) | | |
| Power-on clear (POC) | | 3.5 V ±0.2 V | 1.59 V ±0.15 V | | | | 1.59 V ±0.15 V | | |
| Other | | *4 *5 | Manchester code generator, buzzer output | Manchester code generator, buzzer output, remote control receiver | | Manchester code generator, buzzer output, remote control receiver, clock output | – | – | – |
| Operating temperature | | | $T_A$ = –40 to +85°C (model with expanded temperature range planned) | | | | $T_A$ = –40 to +85°C | | |

*1. Under development
*2. TM0 and TM5 can be connected in cascade and used as a 24-bit event counter.
*3. Supports LIN for 1 channel only
*4. Timer for 10-bit inverter control, real-time output port, Hi-Z output controller
**Remark** The specifications of products still under development or in planning are subject to change without notice.

*5. Timer for 10-bit inverter control, real-time output port, Hi-Z output controller, 16-bit up/down counter, buzzer output
*6. Only supported in the μPD78F0363D, 78F0376D, 78F0386D, 78F0397D

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## List of Partner Companies (listed in no particular order)

**Matsubara.K Corporation**
http://www.mtbrk.com

**Synchro-work Corporation**
http://www.synchro.co.jp/en/index_en.html

**Liberty Corporation**
http://www.liberty-rom.com

**ROMTEC.Inc**
http://www.romtec.co.jp

**ARROW Electronics (UK) Ltd**
http://www.arrowne.com

**Gleichmann & Co. Electronics GmbH**
http://www.msc.de

**MSC Vertriebs GmbH**
http://www.msc.de

**ertec GmbH**
http://www.ertec.de

**Telford Industries Pte Ltd**
http://www.telfordgp.com

**Source Electronics Corporation**
http://www.sourcee.com

**Naito Densei Machida Mfg. Co., Ltd.**
http://www.ndk-m.co.jp/asmis/eng

**Yokogawa Digital Computer Corporation**
http://www.yokogawa-digital.com/emb/en/

**Wave Technology Co., Ltd.**
http://www.y1000.com/index_e.html

**TOKYO ELETECH CORPORATION**
http://www.tetc.co.jp/e_tet.htm

**HIROSE ELECTRIC CO., LTD.**
http://www.hirose.com

**Application Corporation**
http://www.apply.co.jp/index_eng.html

**Interface Co., Ltd.**
http://www.itf.co.jp

**Sunhayato Corporation**
http://www.sunhayato.co.jp

**TAKUMI SHOJI CO., LTD**
http://www.takumic.co.jp

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